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**“EXPERIMENTAL INVESTIGATION ON RECYCLED CONCRETE  
AGGREGATE WITH BITUMINOUS MIXTURE”.**

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**ABSTRACT**

Now a days increasing population in the world, then the constructions for living humans could be more like houses, bridges, apartments etc. Rapidly wastage of concrete aggregates is increasing. To minimize the wastage of concretes by utilizing properly with hot mix asphalt mixtures for construction of road pavements. The objective of this study is to understand the vitality of using RCA for the construction of bituminous pavements. Recycled concrete aggregates (RCA) materials are resulted from milling process. In this study samples of Recycled concrete aggregates (RCA) materials were collected and analysed for suitability of their usage in flexible pavements. Their characteristics including gradation, Aggregate Impact value, Aggregate Crushing value, Specific gravity, Flakiness Elongation Index, Loss Angles Abrasion value, and Water absorption were determined and compared to the standard specifications. The present study deals with evaluation of Marshall Stability, de-formation and the moisture damage resistance values of HMA which is mixed with RCA in varying proportions.. The Marshall mix design method was adopted in this study to determine the optimum binder content (OBC) for the asphalt mixes containing five aggregate combination with RCA contents of 0, 10, 20, 30 percent was found to be 5, 5.5, 6 percent which is optimum respectively.

Large quantities of natural aggregates (NA) are required in the manufacturing of asphalt mixtures for pavements. The extraction of NA generates high environmental impacts that

negatively affect environmental preservation and conservation. Diverse alternative materials obtained in construction and demolition processes in civil construction worked have been studies as possible replacements for NA, with the purpose of reducing these environmental impacts. The foregoing study presents a state of knowledge review referring to the use of recycled concrete aggregates (RCA) when these are used in the manufacturing of asphalt mixtures (mainly hot-mix asphalt HMA type). Environmental aspects are presented, as well as possible benefits and limitations of using RCA as replacements for NA in asphalt mixtures. However, it is not possible to establish a behavior pattern, since the characteristics of the RCA are very heterogeneous and vary from the original source of the concrete. It is highlighted from the literature that RCA has a wide potential for use in the manufacture of asphalt mixtures, since in most studies, the mixtures with these materials comply the quality requirements contemplated by the construction specifications, mainly in low-volume roads. Additionally, based on the literature review, some recommendations and suggestions are presented for future research. Effective management and handling of construction and demolition waste (CDW) can yield significant technical and environmental benefits for road pavement construction.

**KEYWORDS:-** Recycled Concrete Aggregate (RCA), Hot Mix Asphalt (HMA), Bituminous Mixture, Marshall Mix Design, Flexible Pavement, Natural Aggregate Replacement, Sustainable Pavement Materials, Road Construction.

### **INTRODUCTION:**

The rapid growth of urbanization, infrastructure development, and demolition activities has led to a continuous increase in construction and demolition waste, especially waste concrete. At the same time, road construction demands large quantities of natural aggregates, which puts pressure on natural resources and increases environmental impacts. Recycled concrete aggregate (RCA) has emerged as a promising sustainable alternative to natural aggregate in bituminous mixtures, particularly for flexible pavements. RCA is obtained by crushing demolished concrete and reusing it in new pavement layers, helping reduce landfill disposal, conserve virgin materials, and lower transportation-related emissions. However, RCA generally has a rougher surface, higher porosity, and greater water absorption due to adhered mortar, which may affect the performance of asphalt mixes. Therefore, it is important to evaluate its engineering properties and behavior in bituminous mixtures before large-scale use. This study focuses on the experimental investigation of RCA in hot mix asphalt by examining

aggregate properties, bituminous binder properties, and Marshall mix design parameters such as stability, flow, void content, and optimum bitumen content. The work aims to assess the suitability of RCA as a partial replacement for natural aggregates in pavement applications and to identify an optimum RCA percentage that provides acceptable strength and durability for road construction.

## **OBJECTIVES**

- Determine the physical properties of natural aggregates and recycled concrete aggregates (RCA).
- Evaluate the effects of using RCA in bituminous mixture in terms of stability and flow value by using Marshal Mix design method.
- Compare the test results with the performance of the traditional control convention asphalt mixes in laboratory with addition of RCA.

## **METHODOLOGY**

### **Aggregates**

Aggregates are mainly used in building constructions and road pavements. material used for mixing with cement, bituminous, lime ,gypsum or other purposes. in pavements the amount of aggregates in asphalt pavement mixtures is generally 90-95 percent by weight and 75 - 85 percent by volume.

Aggregates are primarily responsible for load supporting capacity of a pavement. these are divided into following categories.

### **Bituminous:**

1. Bitumen, also known as asphalt in the United States, is a substance produced through the distillation of crude oil that is known for its waterproofing and adhesive properties.
2. Bituminous materials are used for road construction, roofing, waterproofing, and other applications as required grade such as VG-10, VG-20, VG-30, VG-40.

### **Recycled Concrete Aggregates:**

Recycled concrete aggregate(RCA) are aggregates obtained by recycling clean concrete waste from processing of demolition renovation of buildings , highways, bridges etc.

### **Aggregate tests(IS-2386):**

Aggregates influence, to a greater extent, the load transfer capability of pavements and slabs.

Therefore, before using for construction, it is necessary that they should be completely tested. Not only the aggregates should be strong and durable, but they should also have proper shape and size to make the element slab/pavement act monolithically.

### **Bituminous**

Experience in using bitumen in engineering projects has led to the adoption of certain test procedures that are indicative of the characteristics that identify adequate performance levels. Some of the tests have evolved with the development of the industry and are empirical methods. Consequently it is essential that they are carried out in strict compliance with the recommended procedures if they are to be accurate measurements of the (VG-30)grade bitumen's properties.

Viscosity grade bitumen in four different types including VG10, VG20, VG30 and VG40 is the most widely used bitumen in India

VG10: bitumen is the softest grade of viscosity bitumen. This type of bitumen is widely used for spraying applications and surface coating. VG 10 bitumen means that your bitumen is also suitable for paving roads in a very cold climate instead of the old 80/100 penetration grade.

VG-20: bitumen is a grade of viscosity bitumen used in cold climatic and high altitude regions. In

North India, vg20 is used for road construction in hot mix asphalt. The standard penetration value of bitumen viscosity grade VG-20 is 60 mm at 25 C. The absolute viscosity of VG-20 bitumen is 1600 to 2400 poise at 60 C.

VG 30: bitumen. This bitumen is primarily used for the construction of extra-heavy bitumen pavements that have to bear significant traffic loads. Bitumen VG30 is the most widely used type of bitumen in road construction, insulation, building construction industries, and also in the production of cutback bitumen.

VG40: bitumen is used in areas in which high pressure comes from heavy traffic loads, such as intersections, near tolls booths, and truck parking lots.

### **RESULT AND DISCUSSION**

The experimental investigation was carried out to evaluate the suitability of Recycled Concrete Aggregate (RCA) in bituminous mixtures by comparing its properties with conventional Natural Aggregates (NA) and analyzing the performance of asphalt mixes using Marshall Mix Design.

## 1. Aggregate Test Results Analysis

The physical properties of both Natural Aggregates (NA) and Recycled Aggregates (RA) were tested as per IS standards.

Crushing Value: NA = 19.07%, RA = 23.16%

Both values are within the permissible limit (<30%), indicating adequate strength. However, RA shows slightly higher crushing value due to the presence of adhered mortar, indicating comparatively lower strength.

Abrasion Value: NA = 16.92%, RA = 19.16%

The abrasion resistance of RA is slightly lower than NA but still within acceptable limits, suggesting it can withstand wear and tear in pavement layers.

Impact Value: NA = 14.37%, RA = 23.31%

RA shows higher impact value, indicating lower toughness compared to NA. This is mainly due to micro-cracks and residual mortar.

Shape Test (Flakiness Index): NA = 33.2%, RA = 32.3%

Both values are within limits (<35%), indicating acceptable particle shape characteristics for pavement use.

Water Absorption: NA = 1.01%, RA = 2.53%

RA shows significantly higher water absorption due to its porous nature, which can affect bitumen demand and durability.

### Discussion:

Overall, RCA satisfies IS specifications but exhibits comparatively lower mechanical strength and higher absorption than natural aggregates. This indicates that RCA can be used in bituminous mixes with proper mix design adjustments.

## 2. Bituminous Material Test Results

The VG-30 grade bitumen used in the study was tested for standard properties: Ductility: 63 cm ( $\geq 50$  cm required)

Softening Point: 49.7°C (within acceptable range) Penetration Value: 62.3 (within 60–70 range) Flash Point: 210°C

Fire Point: 240°C

### Discussion:

All test results fall within specified limits, confirming that the bitumen used is suitable for road construction and compatible with RCA mixes.

### 3. Marshall Mix Design Results

Marshall Stability and flow values were evaluated for mixes containing different percentages of RCA (0%, 10%, 20%, and 30%).

Optimum Bitumen Content (OBC):

0% RCA → 5%

10% RCA → 5.5%

20–30% RCA → ~6%

#### Discussion:

The increase in OBC with higher RCA content is due to the higher water absorption and porosity of RCA, which requires more binder for proper coating.

### 4. Marshall Stability and Performance

The Marshall Stability increased with RCA content up to 30%, indicating improved interlocking due to rough surface texture of RCA.

Beyond 30%, stability tends to decrease due to weaker aggregate strength.

Flow values remained within permissible limits, indicating acceptable deformation characteristics.

#### Discussion:

The rough and angular surface of RCA enhances bonding with bitumen, improving stability initially. However, excessive RCA reduces strength due to its internal structure.

### 5. Overall Performance Evaluation

RCA mixes show comparable performance to conventional mixes for low to medium traffic conditions. Increased RCA content improves sustainability but slightly compromises mechanical properties.

Best performance is observed at 30% RCA replacement, which provides a balance between strength, durability, and environmental benefits.

### 6. Final Interpretation

The study demonstrates that:

RCA is a feasible alternative to natural aggregates in bituminous mixtures. Proper mix design is essential due to higher binder requirement.

Up to 30% replacement of natural aggregates with RCA is optimal for satisfactory

performance.

## CONCLUSION

The impact, crushing, and Los Angeles values of selected virgin aggregates in this study were found to be within the limit (i.e., less than 30percent,)The penetration softening point, viscosity, and ductility values of collected VG30 binder were found to be within the limit as per IS codes, and hence found to be appropriate to use for construction of pavements. The optimum bitumen content was found from the above plotted graphs of Bulk den- sity( $G_b$ ),  $V_v$  , VFB, Marshall stability flow values OBC as 5.5percent in R.C.A.The graph shows percentage of RCA increases the stability will be increased until 30 per- cent thereafter it will decreases.so, the more percentage of RCA increases automatically the strength will be decreases. The optimum R.C.A content for the satisfactory Marshall mix design was found 30 per- cent as per above Marshall testresults.

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